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Comparison of four different treatment methods in distal clavicle fractures: Conservative treatment, locking plate, hook plate and tension band wiring

Distal clavicle fracture treatment methods

Gökhan Peker[1], Ahmet Atilla Abdioğlu[2], Sercan Karadeniz[3], Hüseyin Uygun[1], İsmail Yükünç[3], Oğuzhan Aslan[4], Faruk Karaca[4]
[1] Department of Orthopedics and Traumatology, University of Health Sciences, Trabzon Kanuni Education and Research Hospital
[2] Department of Orthopedics and Traumatology, Fatih State Hospital
[3] Department of Orthopedics and Traumatology, Yavuz Selim Bone Diseases and Rehabilitation Hospital
[4] Department of Orthopedics and Traumatology, Faculty of Medicine, Karadeniz Technical University, Trabzon, Turkey

Abstract

Aim: This study aimed to observe the effects of the conservative treatment, locking plate, hook plate and tension band fixation techniques used for distal clavicle fractures (DCF) on fracture healing, pain, functional outcomes and complications.

Material and Methods: Ninety-four patients treated conservatively and surgically for DCF between 2016 and 2020 were included in the study. Age, gender, Neer classification of the fracture, treatment type, fracture side, fracture healing period, Constant shoulder outcome score, Visual Analog Scale (VAS) scores and complications were examined. Statistical analysis findings were evaluated with the IBM SPSS 28 program at $p<0.05$ significance level.

Results: Of the patients, 77 % were male and 23% were female. 51% of individuals were under 40 years of age. The median follow-up time was 13 months. Conservative treatment was applied to 34% of the individuals, locking plate to 36.2%, hook plate to 14.9% and tension band wiring to 14.9%. There was a moderate negative correlation between the VAS Score and the Constant Score ($p<0.05$). There was no statistically significant difference between the groups in terms of Constant scores, VAS scores and fracture healing ($p>0.05$). Complications were seen in the hook plate and tension band wiring groups, but not in the locking plate group.

Discussion: There is no optimal treatment method for DCFs. In this study, no significant difference was found between methods. The complication rate with the locking plate method is lower than with other surgical methods.

Keywords

Distal Clavicle Fracture, Hook Plate, Locking Plate, Tension Band Wiring, Conservative Treatment

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Corresponding Author: Gökhan Peker, Department of Orthopedics and Traumatology, University of Health Sciences, Trabzon Kanuni Education and Research Hospital, Trabzon, Turkey.
E-mail: drgokhanpeker@gmail.com P: +90 532 588 70 51
Corresponding Author ORCID ID: https://orcid.org/0000-0002-6211-6645

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Introduction

Distal (lateral third) clavicle fractures (DCF) are less common than mid-shaft fractures in adults, most often occur between 30 and 50 years of age and represent 10%–30% of all clavicle fractures [1]. The management of DCF is challenging due to the different fracture patterns and a definitive treatment concept has not been established. Fractures are displaced in 50% of cases and, when treated conservatively, can lead to symptomatic malunion or nonunions in 10-44% of cases [2].

While fractures are often sports-related in young active patients, they may occur due to low-energy falls because of low bone quality in the elderly population [3]. There is no consensus on the best classification system or the ideal treatment approach considering that high nonunion rates have been reported [4].

Clavicle is divided into 3 anatomical regions: medial, middle, and lateral [5]. First of all, the classification was made according to the regions where the fractures occur, but it could not provide sufficient guidance in the treatment of DCFs [6]. Later, based on the relationship of the coracoclavicular ligament responsible for the vertical stability of the fracture, the classification of DCFs was defined by Neer and is still widely used [1, 6, 7].

In the surgical treatment of DCF, rigid internal fixation using a locking plate or hook plate, coracoclavicular (CC) screws, tension band wiring with Kirschner and cerclage wires, CC stabilization with buttons, sutures, anchors, tapes, cables and synthetic grafts, autografts or allografts, and mixed techniques can be used [2, 8]. Currently, there is no gold standard method in fixation [8].

The main purpose of this study is to observe the effects of conservative and different surgical treatment methods on fracture healing, pain, functional outcomes and complications in DCF.

Material and Methods

This study was conducted on patients treated for DCFs between January 2016 and December 2020. Local ethics committee approval was received on 20.01.2023 with the code 2423785961. Data of patients from three centers were analyzed retrospectively from hospital records. Patients whose data and x-rays were available in hospital records were included in the study. Missing information in the records and the last outcome scores were completed by contacting the patients by phone and calling them for the final control. Patients whose data could not be assessed were excluded from the study.

Age, gender, Neer classification of the fracture, treatment type, fracture side, fracture healing period, Constant shoulder outcome score and Visual Analog Scale (VAS) scores at the last follow-up and complications were examined.

Neer classification was used in fracture typing. Neer Type I and III injuries in which the CC ligaments are intact are stable, and Type II and V injuries are unstable [3]. Displaced fractures are considered the subtypes IIA, IIB and V, which usually require operative intervention. In type IV fracture displacement may occur, but the ligaments are intact [7, 9].

According to the registration data, 112 patients with lateral 1/3 clavicle fractures were identified. At the last follow-up, 18 patients with missing data could not be reached by phone and were excluded from the study. Ninety-four patients treated conservatively and surgically were included in the study. Locking clavicle plate, hook plate and tension band wiring with Kirschner and cerclage wires were used in the surgical treatment. Removal of hook plates and K-wires was performed at least 6 months after surgery.

Statistical Analysis

Descriptive statistics for categorical variables (demographic characteristics) were presented as frequencies and percentages. The conformity of numerical variables to normal distribution was checked with the Shapiro-Wilk test. Descriptive statistics of numerical variables were presented for median (Med), minimum and maximum (Min-max) values for data that do not show normal distribution. The Mann-Whitney test was used to compare two independent groups to determine whether they were normally distributed. In comparisons of data from more than two groups, if the assumption of normality was not met, the Kruskal-Wallis test was applied. Then, the relationships between quantitative variables that did not comply with normal distribution were examined with Spearman's correlation analysis. In the interpretation of the correlation coefficient, "very weak correlation" if <0.2, "weak correlation" if 0.2-0.4, "moderate correlation" if 0.4-0.6, "high degree of correlation" if 0.6-0.8 and "very high degree of correlation" were used if>0.8. Relationships between categorical variables were examined with the Fisher test. Statistical analysis findings were evaluated with the IBM SPSS 28 program at p<0.05 significance level.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

Ninety-four DCFs comprised the final cohort, consisting of 77 % males and 23% female. 51% of individuals were under 40 years of age. Twenty-four (25.5%) of these fractures were Neer

Table 1. Demographic data of the patients

Variable	n	%
Gender		
Male	72	77
Female	22	23
Age		
<40	48	51
>40	46	49
Neer Classification		
I	24	25,5
IIA	34	36,2
IIB	20	21,3
III	14	14,9
V	2	2,1
Treatment Method		
Conservative	32	34
Locking plate	34	36,2
Hook Plate	14	14,9
Tension Band Wiring	14	14,9
Side		
Right	54	57
Left	40	43

(n: Number of patients)

type I, 34 (36.2 %) were Neer type IIa, 20 (21.3 %) were Neer type IIb, 14 (14.9 %) were Neer type III, 2 (2.1 %) were Neer type V. The median follow-up period was 13 months. Conservative treatment was applied to 34% of the individuals, locking plate to 36.2%, hooked plate to 14.9% and tension band treatment to 14.9%. The fracture was on the right side in 57% of the patients and on the left side in 43%. Demographic findings of the patients are presented in Table 1.

Neer classifications and the treatment method applied are shown in Table 2. Among the 24 patients with Neer type I, 18 (75 %) patients were treated conservatively and 6 (25 %) were treated with a locking plate. In Neer type IIa, 8 (23.5 %) patients were treated conservatively, 24 (70.6 %) patients were treated with locking plate and 2 (5.9 %) patients were treated with tension band wiring. In Neer type IIb, 6 (30 %) were treated conservatively, 4 (20 %) with locking plate, 4 (20 %) with a hook plate and 6 (30 %) with tension band wiring. Of the Neer type III patient group, 10 (71.4 %) patients were treated with hook plate and 4 (28.6 %) patients were treated with tension band wiring. Two (100 %) patients in Neer type V group were treated with tension band wiring.

Table 2. Neer classification and treatment methods

Variable		Treatment Method			
	Group	Conservative	Locking Plate	Hook plate	Tension Band Wiring
Neer Classification	I	18 (75)	6 (25)	0	0
	IIA	8 (23.5)	24 (70.6)	0	2 (5.9)
	IIB	6 (30)	4 (20)	4 (20)	6 (30)
	III	0	0	10 (71.4)	4 (28.6)
	V	0	0	0	2 (100)

There was no statistically significant difference between the VAS and Constant shoulder scores and fracture healing times (days) of the individuals on the basis of gender, age, Neer fracture types, treatment methods and fracture sides (p>0.05) (Table 3). There was a moderate negative correlation between the VAS Score and the Constant Score (p<0.05).

Overall, eight individuals (8.5 %) had post-operative complications. Two (14 %) of the patients who underwent hook plate developed nonunion, and the other two (14 %) developed osteolysis in the acromion. Hook plates were removed. Non-unions were treated with a locking plate and auto-grafting technique. Also, there was three (21 %) hardware failure and 1 (7 %) K-wire migration requiring revision surgery in patients treated with tension band wiring. No complications were observed in patients treated with a locking plate.

Discussion

Since DCFs are extremely unstable and therefore have a high rate of nonunion, various treatment methods have been developed, but there is still no gold standard treatment [9]. In this study, we compared conservative treatment and three different surgical treatment methods: hook plate, locking plate and tension band wiring. We found that all these methods were effective in terms of functional recovery. There was no difference between the different treatment modalities in terms of fracture healing periods, post-treatment Constant and VAS scores. No complications were observed only in the locking plate group.

Clavicle fractures (CF) usually heal without difficulty, but distal fractures account for 10-30% of all CF cases and 30-45% of nonunion cases [1, 10]. In particular, DCFs are associated with

Table 3. Comparisons of CONSTANT scores, VAS scores and fracture healing periods according to demographic characteristics.

Variable	CONSTANT score				VAS score				Fracture Healing Period (Day)			
	Med	Min	Max	P	Med	Min	Max	p	Med	Min	Max	p
Age												
<40	88	50	100	0.533^{U}	2	0	5	0.869^{U}	100	40	200	0.398^{U}
>40	90	62	100		2	0	5		90	45	200	
Gender												
Male	88	50	100	0.707^{U}	2	0	5	0.172^{U}	95	40	200	0.358U
Female	91	66	100		2	1	5		105	45	200	
Neer Classification												
I	88	68	93	0.068^{KW}	2	1	5	0.247^{KW}	95	60	140	0.389^{KW}
IIA	91	50	100		1	0	4		120	40	180	
IIB	80	63	96		0	0	0		75	40	200	
III	100	62	100		2	0	5		60	50	200	
V	100	100	100		2	1	4		180	180	180	
Treatment Method												
Conservative	86	68	94	0.539^{KW}	3	0	5	0.406^{KW}	90	60	130	0.074^{KW}
Locking plate	90	63	100		2	0	5		140	40	180	
Hook Plate	95	66	100		2	0	4		120	60	200	
Tension Band Wiring	96	62	100		1	0	4		50	45	180	
Side												
Right	90	50	100	0.698^{U}	2	0	5	0.383^{U}				
Left	89.5	62	100		2	0	5					

Med: Median, Min: Minimum, Max: Maximum p: significance value U: Mann- Whitney-U test KW: Kruskall-Wallis test the highest nonunion rates. The decision to perform surgery for these fractures is controversial and may depend on the amount of fracture displacement and patient demands [1].

Conservative treatment is still mostly preferred in DCFs. There is also some evidence to suggest that conservative treatment may be appropriate for Neer types II and V, the most common types of fractures treated surgically [11, 12]. In a short-term follow-up study by Kihlström et al., half of the patients treated surgically had their implants removed afterwards. Patients who underwent surgical treatment had worse Constant scores and were less satisfied with the cosmetic result than non-surgical patients [12]. Contrary to this meta-analysis, in a multicenter randomized study, no difference in functional outcomes was found between operative and nonoperative treatment of Neer type II DCFs, whereas conservative treatment led to more complications, including a moderate rate of nonunion, and dissatisfaction with shoulder appearance. The second surgery was required to correct this situation. The operative method provided a safe treatment option with few complications, but often required removal of the secondary implant, especially with hook plate fixation [13]. In our study, no difference was found between conservative treatment and surgical treatments in terms of functional results and fracture healing period. We recommended removal of hook plates and K-wires at least 6 months after surgery.

In a systematic review and meta-analysis, worse clinical outcomes have been demonstrated with the hook plate technique in the treatment of DCFs, with locking plate fixation considered one of the best treatment options available [2]. Yoon et al. compared the hook plate group and the locking plate group in DCFs. They obtained satisfactory radiological results in both groups and recommended both methods as a good treatment option [14]. In a national review in the United Kingdom, authors declared that the use of hook plates is still the most common, with the use of locking plates not far behind [11]. Many authors have recommended the removal of the hook plate after fracture healing has occurred. A hook plate has been noted to cause discomfort in shoulder motion and cause additional complications such as subacromial impingement and rotator cuff injury. In the study evaluating the results of clavicle hook plate in Neer type II clavicle fractures, 1 implant dislocation (2.2%), 2 cases of pseudarthrosis (4.5%), 2 superficial wound infections (4.5%), 2 patients with hypertrophic scar tissue (4.5%) and 3 cases of acromial osteolysis (6.8%) were observed. Thirty patients (68%) reported discomfort due to the implant. A high rate of implant-related discomfort was observed and therefore they recommended removal of the implant as soon as consolidation had occurred [15]. In another meta-analysis, although the hook plate showed a better radiological result, the locking plate showed a better functional result with fewer complications and no need for implant removal [16]. In our study, no difference was found between patients treated with hook plates and locking plates in terms of functional results and fracture healing. As an important difference, it can be stated that there was no complication in those treated with the locking plate.

One of the oldest surgical treatment methods in lateral clavicle fracture is tension band wire fixation but complications such as wire migration, loss of reduction, nonunion and skin ulceration have been reported in the literature [17, 18]. Both techniques restore shoulder function to an adequate level, but due to these complications, a clavicular hook plate is recommended [19]. Hsu et al. concluded that the tension band method provided faster functional recovery than hook plate fixation [20]. Choi et al. performed coracoclavicular stabilization in addition to the tension band fixation technique and provided minimal incision and stable fixation in people with DCFs without causing further acromioclavicular joint damage [21]. In our study, no difference was found between the patients treated with tension band wiring and other surgical methods in terms of functional outcomes and fracture healing. Complication rates of hook plate and tension band wire fixation were equal. Complications of hook plate fixation include acromial osteolysis, impingement, pain, hardware failure, and plate migration [22, 23]. In the group treated with hook plate, 2 (14 %) cases had osteolysis and 2 (14 %) cases had nonunion requiring hardware removal. There are authors who advocate routine removal of the hook plate 4 to 6 months after surgery to prevent acromial osteolysis [24].

Complications of tension band wiring with K-wires include K-wire migrations, loss of reduction, and hardwire breakage [25]. Among those treated with tension band, 4 developed complications, 1 (7 %) of which was K-wire migration and 3 (21 %) of which were implant failure. The implant was removed in all patients. Those with implant failure were treated with hook plate. In our study, no difference was observed between hook plate and tension band wiring methods in terms of complications. No complications were seen in the locking plate group.

Limitation

This was a retrospective, non-randomized study. The surgeries were performed by more than one surgeon and the surgeons' level of experience could influence the outcomes. Conducting prospective studies with a larger number of samples would be beneficial in the future.

Conclusion

There is no gold standard treatment method for DCFs as in the studies mentioned above. In our study, three different surgical methods along with the conservative treatment method were evaluated in terms of functional results and fracture healing, and no significant difference was found between the methods. While the surgeon's experience and the type of fracture are important in choosing the treatment method for fractures, we conclude that the low complication rate in the locking plate method should also be taken into consideration.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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